BOUNDS FOR PERCOLATION THRESHOLD OF INTERFACIAL TRANSITION ZONES SURROUNDING COMPLEX GEOMETRIC AGGREGATES IN CEMENTITIOUS COMPOSITES

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ABSTRACT

Experimental data suggests that aggregates within matrix induce significant interface transition zones (ITZs) surrounding aggregates, which have a considerable higher porosity than matrix. A group of connected clusters for ITZs can lead to a percolation inside of cementitious composites. Understanding the percolation threshold of interface transition zones (ITZs) is of great importance in the prediction of transport and mechanical properties of cementitious materials.

In this work, we firstly present a theoretical scheme for determining the excluded volumes of anisotropic particles. We derive an explicit formula for the excluded volume of the composite body between a ITZ and a complex geometric aggregate in terms of the ITZ thickness, and the volume, surface area and the radius of mean curvature of the aggregate and ITZ. These basic geometrical properties are computed for a wide variety of aggregate shapes with random orientations, including ellipsoid, spherocylinder and convex polyhedron-like grains. Applying such information, we subsequently calculate the lower bound for percolation threshold of ITZs around complex geometric aggregates on the basis of continuum percolation models. In addition, the proposed percolation bounds are compared with the numerical results and experimental data from the literature, which presents a reliable accuracy for the bound model. Moreover, we also discuss upper bound for percolation threshold of ITZs. Results show that the continuum percolation of ITZs mainly relies on the shape and surface information of anisotropic particles. Such theoretical bounds can further provide analytical insights in evaluating the ITZs percolation effect on the transport and mechanical properties of particle-reinforced composites.

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